Applied Geotechnical Engineering Consultants, Inc.

GEOTECHNICAL INVESTIGATION

PROPOSED SNOW COLLEGE HOUSING
SNOW COLLEGE

100 EAST 100 NORTH

EPHRAIM, UTAH

PREPARED FOR:

DFCM - STATE OF UTAH
4110 STATE OFFICE BUILDING
SALT LAKE CITY, UTAH 84114

ATTENTION: KURT BAXTER

PROJECT NO. 1100909 **DECEMBER 23, 2010**

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

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EXECUTIVE SUMMARY

1. The subsurface soil encountered at the site consists of fill overlying clay which extends the full depth investigated. The thickness of the fill encountered in the borings may be up to 9 feet. The fill generally consists of lean clay that appears to have variable compaction and contains some debris including glass, wood and paint chips in the upper 3 to 4 feet. The fill may only be up to 3 to 4 feet thick. The soil should be observed at the time of construction to determine the thickness of existing fill. Unsuitable fill should be removed from below the proposed building.

2. No subsurface water was encountered to the maximum depth investigated, approximately 25½ feet.

3. The proposed building may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil and may be designed for a net allowable bearing pressure of 1,500 pounds per square foot. Footings bearing on at least 2 feet of compacted structural fill may be designed for a net allowable bearing pressure of 3,000 pounds per square foot.

4. The upper soil consists of clay. This clay will result in construction equipment access difficulties when the clay is very moist to wet such as in the winter and spring or at times of prolonged rainfall. Placement of 1 to 2 feet of gravel will provide limited support for construction equipment when the upper soil consists of very moist to wet clay.

5. Geotechnical information related to foundations, subgrade preparation, pavement design and materials is included in the report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed Snow College Housing to be located at the northeast corner of 100 East and 100 North in Ephraim, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for foundations and pavement. The study was conducted in general accordance with our proposal dated November 17, 2010.

Field exploration was conducted to obtain information on the subsurface conditions. Samples obtained from the field investigation were tested in the laboratory to determine physical and engineering characteristics of the on-site soil. Information obtained from the field and laboratory was used to define conditions at the site for our engineering analysis and to develop recommendations for the proposed foundations and pavement.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

At the time of our field investigation, the western portion of the site was a landscaped area consisting of grass and trees. There is a two-story, brick building with a full-depth basement in the southeast portion of the site. There are some pavement and walk-ways in other portions of the site.

We understand that there was a church building in the western portion of the site that was demolished several years ago. The maintenance personnel indicate that the building had a shallow depth boiler room.

The ground surface is relatively flat and slopes gently down to the west and northwest.

There are school buildings to the north, south and east of the site and residential properties to the west.

FIELD STUDY

The field study was conducted on December 9, 2010. Five borings were drilled at the approximate locations indicated on Figure 1 using 8-inch diameter, hollow-stem auger powered by an all-terrain drill rig. The borings were logged and soil samples obtained by a representative from AGEC. Logs of the subsurface conditions encountered in the borings are graphically shown on Figure 2 with legend and notes on Figure 3.

SUBSURFACE CONDITIONS

The subsurface soil encountered at the site consists of fill overlying clay which extends the full depth investigated. The thickness of the fill encountered in the borings may be up to 9 feet. The fill generally consists of lean clay that appears to have variable compaction and contains some debris including glass, wood and paint chips in the upper 3 to 4 feet. The fill may only be up to 3 to 4 feet thick. The soil should be observed at the time of construction to determine the thickness of existing fill. Unsuitable fill should be removed from below the proposed building.

A description of the various soils encountered in the borings follows:

> Fill - The fill consists of lean clay which is moist to very moist, brown to dark brown, mottled and contains occasional pieces of debris including glass, wood and paint chips in the upper 3 to 4 feet.

Laboratory tests performed on samples of the fill indicate that it has moisture contents ranging from 18 to 21 percent and dry densities ranging from 100 to 108 pounds per cubic foot (pcf).

Lean Clay - The clay contains occasional thin silt and sand layers. It is medium stiff to very stiff, slightly moist to very moist and brown.

Laboratory tests performed on samples of the clay indicate that it has natural moisture contents ranging from 18 to 24 percent and natural dry densities ranging from 96 to 105 pcf. Results of a consolidation test performed on a sample of the clay indicate that the clay will compress a moderate amount with the addition of moderate loads. Results of the consolidation test are presented on Figure 3. An unconfined compressive strength of 1,440 pounds per square foot (psf) was measured for a sample of the clay.

Results of the laboratory tests are summarized on Table I and are included on the logs of the borings.

SUBSURFACE WATER

No subsurface water was encountered to the maximum depth investigated, approximately 25½ feet.

PROPOSED CONSTRUCTION

We understand that the proposed building will be a three-story, steel-frame structure with the lower floor level at grade. We understand that a utility basement will be constructed under a portion of the building. This basement may be up to approximately 5,000 square feet in size. We have assumed maximum column loads of 200 kips and maximum wall loads of 8 kips per lineal foot.

We anticipate that some pavement will be constructed as part of the proposed development. We have assumed traffic will consist predominantly of car traffic with occasional delivery trucks and two garbage trucks per week.

If the proposed construction, building loads or traffic is significantly different from what is described above, we should be notified so that we can reevaluate the recommendations given.

RECOMMENDATIONS

Based on the subsurface conditions encountered, laboratory test results, and the proposed construction, the following recommendations are given:

A. Site Grading

We have assumed that the site will not be raised more than 2 feet above existing grade.

1. Subgrade Preparation

Prior to placing grading fill or base course, the topsoil, unsuitable fill, organics, debris and other deleterious material should be removed. The upper natural soil consists predominantly of clay and will be easily disturbed by construction traffic when the clay is very moist to wet. Placement of 1 to 2 feet of granular fill consisting predominantly of gravel and having less than 15 percent passing the No. 200 sieve will provide limited support for construction traffic when the subgrade consists of very moist to wet clay.

Consideration may be given to placing a support fabric between the subgrade and granular fill to facilitate construction.

2. Excavation

Excavation at the site can be accomplished with typical excavation equipment. Excavations that extend into the very moist soil may require the use of excavation equipment supported from outside and above the excavation.

A flat cutting edge should be used for excavation equipment when excavating for foundations, to reduce disturbance of the bearing soil.

3. Compaction

Compaction of materials placed at the site should equal or exceed the minimum densities as indicated below when compared to the maximum dry density as determined by ASTM D 1557.

Fill To Support	Compaction
Foundations	≥ 95%
Concrete Slabs and Pavement	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

To facilitate the compaction process, fill should be compacted at a moisture content within 2 percent of the optimum moisture content.

Base course should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557.

Fill and pavement materials should be frequently tested during construction for compaction.

4. <u>Materials</u>

Material placed as fill to support foundations should be non-expansive granular soil. The clay is not recommended for use as structural fill but may be used in pavement areas or as utility trench backfill if the organics, debris and other deleterious materials are removed. The moisture of the on-site soil is generally near or above the optimum moisture content and may require drying to facilitate compaction. Drying of the soil may not be practical during cold or wet periods of the year.

Listed below are materials recommended for imported structural fill.

Fill to Support	Recommendations
Footings	Non-expansive granular soil Passing No. 200 Sieve < 35% Liquid Limit < 30% Maximum size 4 inches
Floor Slab (Upper 4 inches)	Sand and/or Gravel Passing No. 200 Sieve < 5% Maximum size 2 inches
Slab Support	Non-expansive granular soil Passing No. 200 Sieve < 50% Liquid Limit < 30% Maximum size 6 inches

5. <u>Drainage</u>

The ground surface surrounding the proposed building should be sloped away from the building in all directions. Roof downspouts and drains should discharge beyond the limits of backfill.

The collection and diversion of drainage away from the pavement surface is important to the satisfactory performance of the pavement section. Proper drainage should be provided.

B. Foundations

1. <u>Bearing Material</u>

With the proposed construction and the subsurface conditions encountered, the building may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. Structural fill should extend out away from the edge of the footings at least a distance equal to the depth of fill beneath footings.

Unsuitable fill, topsoil, organics and other deleterious materials should be removed from below proposed foundation areas.

2. <u>Bearing Pressure</u>

A net allowable bearing pressure of 1,500 psf may be used for spread footings supported on the undisturbed natural soil or on compacted structural fill extending down to the natural undisturbed soil. Footings bearing on at least 2 feet of compacted structural fill may be designed for a net allowable bearing pressure of 3,000 psf.

Footings should have a width of at least 18 inches and a depth of embedment of at least 10 inches.

3. <u>Temporary Loading Conditions</u>

The allowable bearing pressure may be increased by one-half for temporary loading conditions such as wind or seismic loads.

4. Settlement

Based on the subsurface conditions encountered and the assumed building loads, we estimate that total and differential settlement will be less than 1 and ½ inch, respectively.

Care will be required to not disturb the natural soil at the base of foundation excavations to maintain settlement within tolerable limits.

5. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 30 inches below grade for frost protection.

6. Foundation Base

The base of footing excavations should be cleared of loose or deleterious material prior to structural fill or concrete placement.

7. Construction Observation

A representative of the geotechnical engineer should observe footing excavations prior to structural fill or concrete placement.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil.

Topsoil, unsuitable fill, organics and other deleterious materials should be removed from below proposed floor slabs.

2. Underslab Sand and/or Gravel

Free-draining sand and/or gravel (less than 5 percent passing the No. 200 sieve) should be placed below the floor slab to promote even curing of the concrete.

3. Vapor Barrier

A vapor barrier should be placed under the concrete floor if the floor will receive an impermeable floor covering. The barrier will reduce the amount of water vapor passing from below the slab to the floor covering.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings placed on the natural soil or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.35 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. The values listed below assume a horizontal surface adjacent the top and bottom of the wall.

Soil Type	Active	At-Rest	Passive
Clay & Silt	50 pcf	65 pcf	250 pcf
Sand & Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 20 pcf for active and at-rest conditions and decreased by 20 pcf for the passive condition. This assumes a short period spectral response acceleration of 0.69g for a 2 percent probability of exceedance in a 50 year period (IBC 2006 and 2009).

4. Safety Factors

The values recommended above assume mobilization of the soil to achieve soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Faulting and Seismicity

1. Faulting

There are no mapped active faults extending through the site. The closest mapped active fault to the site is the Gunnison Fault located approximately 4 miles to the west of the property (Black and others, 2003).

2. Seismicity

Listed below is a summary of the site parameters for the 2006 and 2009 International Building Code:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	0.69g
c.	One Second Period Spectral Response Acceleration, S_1	0.23g

F. Subsurface Drains

There is a potential for perched water conditions.

Consideration should be given to installing perimeter drains around the below grade floor portions of the building. The perimeter drain system should consist of at least the following items:

1. The underdrain system should consist of a perforated pipe installed in a gravel filled trench around the perimeter of the subgrade floor portion of the building.

2. The flow line of the pipe should be placed at least 18 inches below the finished floor level and should slope to a sump or outlet where water can be removed by pumping or by gravity flow.

3. If placing the gravel and drain pipe requires excavation below the bearing level of the footing, the excavation for the drain pipe and gravel should have a slope no steeper than 1 horizontal to 1 vertical so as not to disturb the soil below the footing.

4. A filter fabric should be placed between the natural soil and the drain gravel. This will help reduce the potential for fine-grained material filling in the void spaces of the gravel.

5. The subgrade floor slab should have at least 6 inches of free-draining gravel placed below it and the underslab gravel should connect to the perimeter drain.

6. Consideration should be given to installing cleanouts to allow access into the perimeter drain should cleaning of the pipe be required in the future.

G. Water Soluble Sulfates

One sample of the natural soil was tested in the laboratory for water soluble sulfate content. Test results indicate there is less than 0.1 percent water soluble sulfate in the sample tested. Based on the results of the test and published literature, the natural soil possesses negligible sulfate attack potential on concrete. No special cement type is required for concrete placed in contact with the natural soil. Other conditions may dictate the type of cement to be used in concrete for the project.

H. Pavement

Based on the subsoil conditions encountered, laboratory test results and the assumed traffic as indicated in the Proposed Construction section of the report, the following pavement support recommendations are given.

1. Subgrade Support

   We anticipate that the subgrade material will consist of clay. We have assumed a California Bearing Ratio (CBR) value of 3 percent which assumes a lean clay subgrade.

2. Pavement Thickness

   Based on the subsoil conditions encountered, assumed traffic, a design life of 20 years for flexible pavement and 30 years for rigid pavement, and methods presented by the Utah Department of Transportation, a flexible pavement section consisting of 3 inches of asphaltic concrete overlying 6 inches of base course is calculated. Alternatively, a rigid pavement section consisting of 5 inches of Portland cement concrete may be used. Thicker pavement sections may be needed if significant heavy truck traffic is expected.

The near surface soil consists predominantly of clay. Approximately 1 to 2 feet of granular borrow may be needed to provide equipment access and facilitate construction of the pavement if construction occurs when the subgrade is very moist to wet.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

The pavement materials should meet the specifications for the applicable jurisdiction. Other materials may be considered for use in the pavement section. The use of other materials may result in the need for different pavement material thicknesses.

b. Rigid Pavement (Portland Cement Concrete)

The rigid pavement thickness assumes that the pavement will have aggregate interlock joints and that a concrete shoulder or curb will be provided.

The pavement materials should meet the specifications for the applicable jurisdiction. The pavement thickness indicated above assumes that the concrete will have a 28-day compressive strength of 4,000 pounds per square inch. Concrete should be air entrained with approximately 6 percent air. Maximum allowable slump will depend on the method of placement but should not exceed 4 inches.

4. Jointing

Joints for concrete pavement should be laid out in a square or rectangular pattern. Joint spacings should not exceed 30 times the thickness of the slab. The joint spacings indicated should accommodate the contraction of the concrete and under these conditions steel reinforcing will not be required. The joints should be approximately one-fourth of the slab thickness.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the borings drilled at the approximate locations indicated on Figure 1 and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the subsurface conditions or groundwater level is found to be significantly different from what is described above, we should be notified to reevaluate our recommendations.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

LICENSED PROFESSIONAL ENGINEER
12/23/10
No. 260053
DOUGLAS R. HAWKES

Douglas R. Hawkes, P.E., P.G.

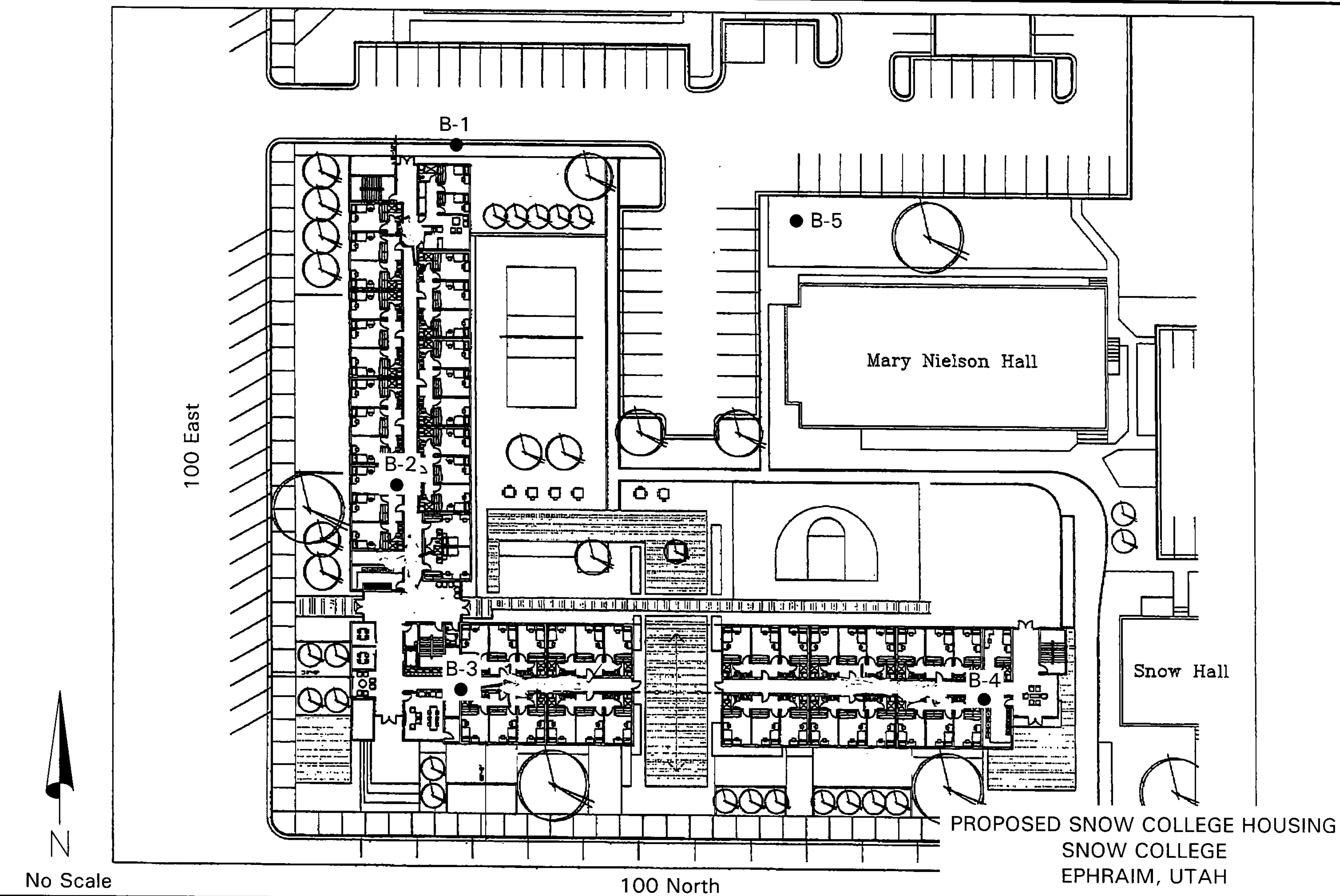
Reviewed by Jay R. McQuivey, P.E.

DRH/dc

REFERENCES

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

International Building Code, 2006 and 2009; International Code Council, Inc. Falls Church, Virginia.



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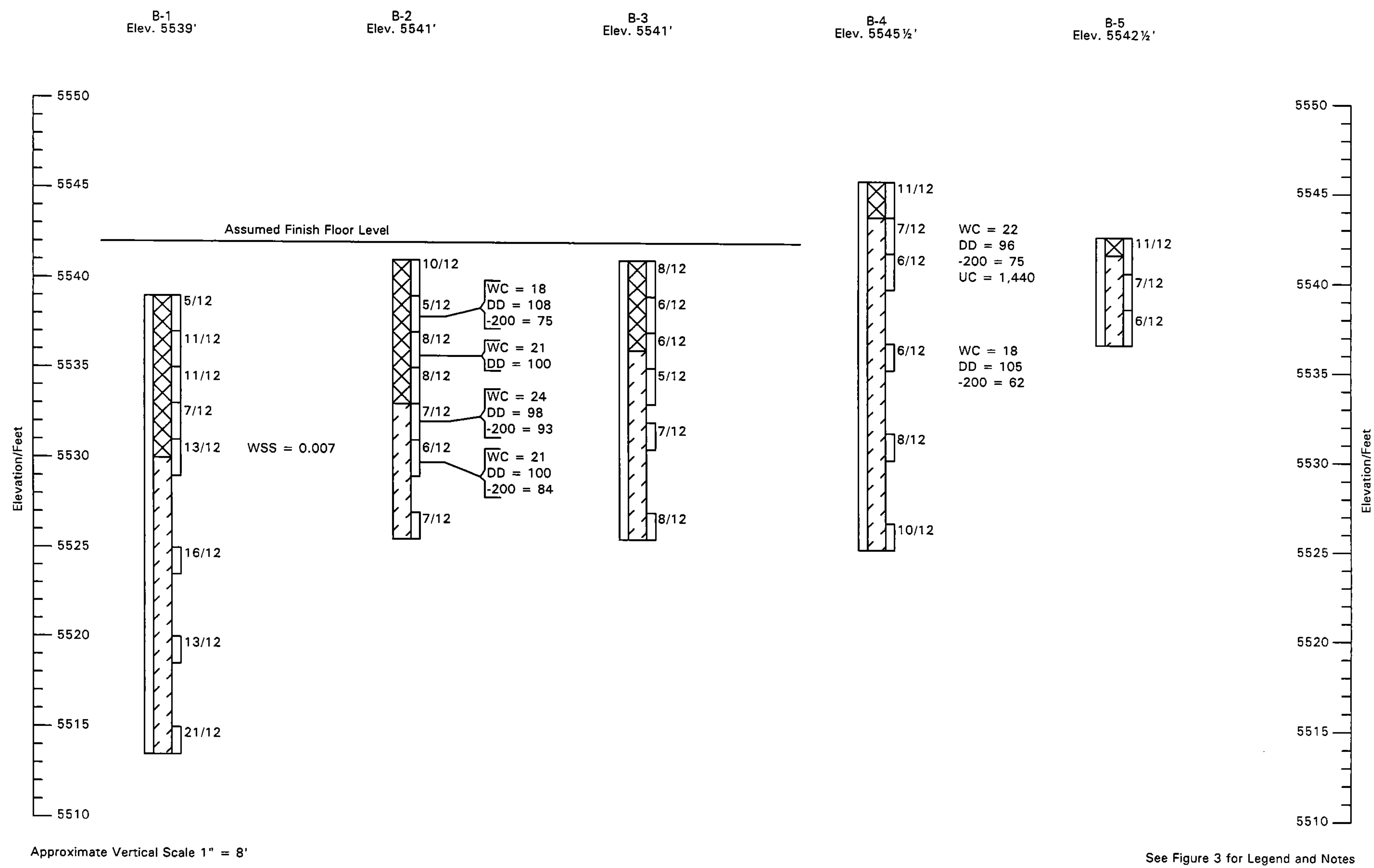
1100909	AGEC	Locations of Exploratory Borings	Figure 1



1100909	AGEC	Logs of Exploratory Borings	Figure 2

LEGEND:

Fill; lean clay, moist to very moist, brown to dark brown, mottled, occasional pieces of debris including glass, wood and paint chips.

Lean Clay (CL); occasional thin silt and sand layers, medium stiff to very stiff, slightly moist to very moist, brown.

10/12 California Drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound automatic hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates slotted 1½ inch PVC pipe installed in the boring to the depth shown.

NOTES:

1. Borings were drilled on December 9, 2010 with 8-inch diameter hollowstem auger.
2. Locations of borings were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of borings were provided by Ludlow Engineering and Land Surveying.
4. The boring locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the boring logs represent the approximate boundaries between material types and the transitions may be gradual.
6. No subsurface water was encountered in the borings at the time of drilling.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing No. 200 Sieve;
   UC = Unconfined Compressive Strength (psf);
   WSS = Water Soluble Sulfates (%).

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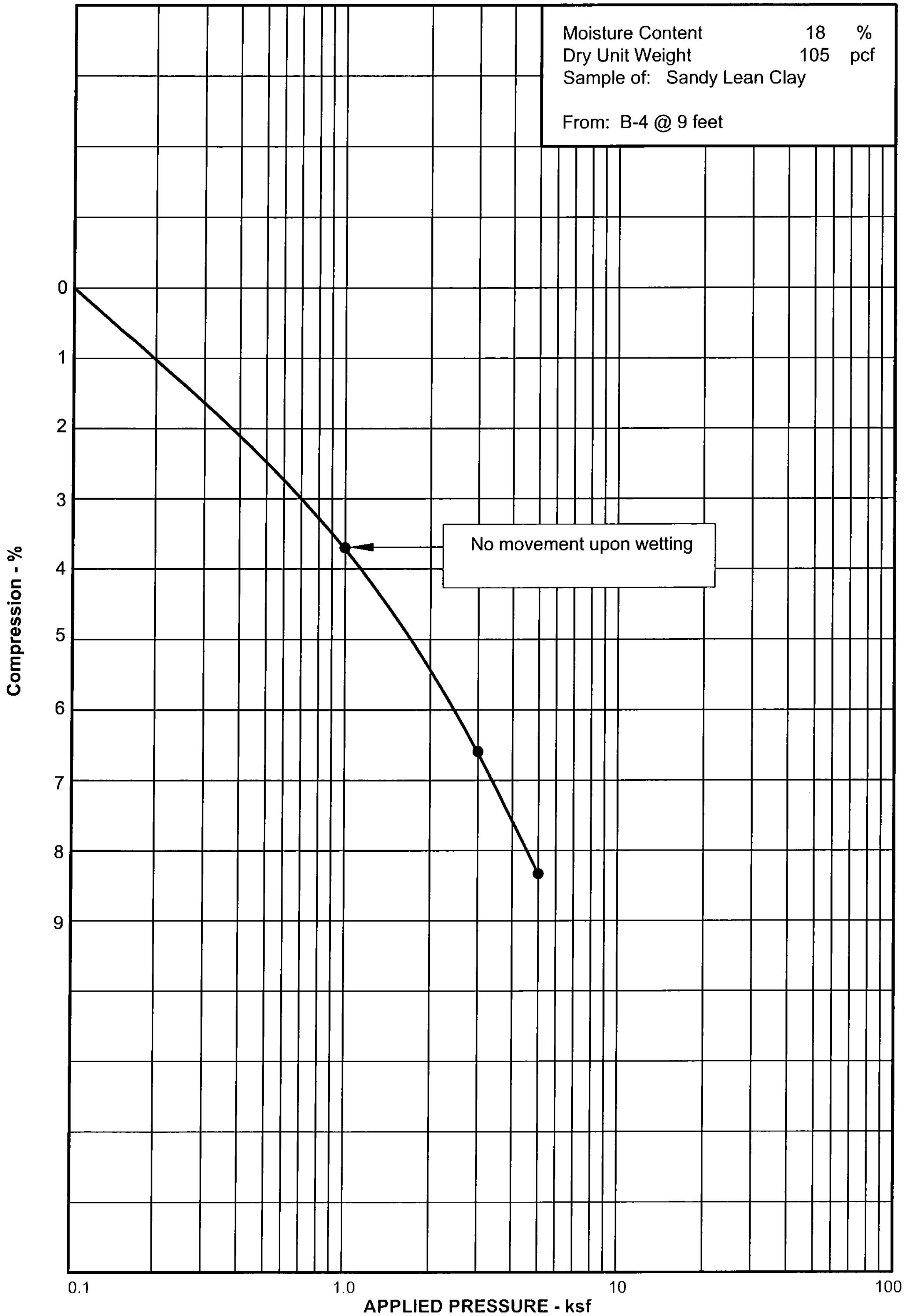

Project No. 1100909

CONSOLIDATION TEST RESULTS

Figure 4

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1100909

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (%)	SAMPLE CLASSIFICATION
BORING	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
B-1	8									0.007	Lean Clay with Sand
B-2	2	18	108			75					Fill; Lean Clay with Sand
	4	21	100								Fill; Lean Clay with Sand
	8	24	98			93					Lean Clay
	10	21	100			84					Lean Clay with Sand
B-4	2	22	96			75			1,440		Lean Clay with Sand
	9	18	105			62					Sandy Lean Clay